

6. Longest duration of disease, seven years; shortest, twenty-one days.

7. Primary lesion seen in eleven cases.

8. Eleven were Wassermann-positive; twenty-one were negative; three, one or two plus (became negative under tartar emetic therapy).

9. Twenty-six showed systemic symptoms.

10. Bilateral bubos in nine; right bubos in seven; left bubos in ten; rectal strictures in ten (including two males); both rectal strictures and bubos in two (women); maxillary and supraclavicular glands involved in one; fistulae (rectovaginal, vesicovaginal, abdominal) one each, and meningeal irritation (lymphogranulomatus meningitis), one.

11. Twelve bubos went to sinus formation; fourteen did not.

12. Cures, seventeen; under treatment at present, six; deaths, one (glomerulonephritis); failed to return to clinic for check-up, eleven (healing being evident when last seen).

In my previous report, covering the treatment of eleven cases, tartar emetic was considered almost specific. However, we now feel that our best results have been obtained through the intravenous use of antigen, which is superior in results to its intradermal or subcutaneous use.

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SAMUEL AYRES, JR., M. D., (2007 Wilshire Boulevard, Los Angeles).—While cases of lymphogranuloma inguinale are being reported with increasing frequency, it is still far from a common condition. Personally, I have never seen a case in private practice, nor has one ever been presented before the Los Angeles Dermatological Society. Practically all of the patients at the Los Angeles County General Hospital have been admitted on the urological or proctological services. Dr. E. F. Hoffman, who has probably seen more cases of this disorder than anyone in Los Angeles, tells me that there have been approximately seventy cases on the urological and proctological services up to the present time (November 25, 1934).

As Doctor Novy has pointed out, the introduction of the Frei test has been of inestimable value, not only from a diagnostic standpoint, but therapeutically as well. In recalcitrant cases it might be worth while to consider maggot therapy. We have recently had a most gratifying result by the use of maggots in a chronic ulcerative granuloma of undetermined etiology of the thigh of a year's duration. The Frei test was negative in this case, but there were many deep sinuses and undermined margins. In view of the remarkable results by the use of maggots in chronic osteomyelitis, it would seem that they might deserve a trial if the Frei antigen treatment is unsuccessful.

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ANTHONY B. DIEPENBROCK, M. D. (450 Sutter Street, San Francisco).—In 1913 Durand, Nicholas, and Favre published an account of this disease and gave it the name "lymphogranuloma inguinale." At that time they were not familiar with a similar entity, now proved to be the same disease, which had been variously described as climatic bubo, strumous bubo, hypertrophic bubo, tropical bubo, non-venereal bubo, and inguinal poradenitis. Bubo, described with the various adjectives named above, had been seen and reported by Trousseau, Jouet, Guerin, Segard, Martin, Ruge, Gooding, Branfoot, Roegholt, and others, in such places as Reunion Island, Mauritius Island, Indo-China, Tonkin, Madagascar, Sumatra, Zanzibar, Madras, Dutch East Indies, and East Central Africa; hence, it was regarded as a purely tropical disease. Trousseau's description, published in 1865, is perhaps one of the best early works on the subject.

European investigations were given an impetus by the work of Durand, Nicholas, and Favre; but these studies were disrupted by the World War.

In 1925, Wilhelm Frei discovered that individuals afflicted with this disease exhibited a cutaneous re-

action when inoculated with a heated saline dilution of pus, aspirated from a fluctuant bubo. The application of Frei's phenomenon has led to the identification of various types of this disease, previously described as estriomene, climatic bubo, chronic elephantiasis, ulceration of the vulva, inflammatory stricture of the rectum, and the so-called genito-anorectal syndrome. Further, the application of Frei's phenomenon led to the recognition of the world-wide distribution of the disease.

An excellent review of the literature has been presented us by H. S. Stannus in the "Proceedings of the Royal Society," London, 1932.

American interest was given a great impetus by the work of Cole, De Wolf, Van Cleve, Sulzberger, and others.

I agree with Doctor Novy that the term "lymphopathia venerea," coined by Sulzberger, should be generally adopted in writing or speaking of the malady.

My associates, Doctors Rodney A. Yoell, James J. McGinnis, James W. Morgan, and I presented before the San Francisco County Medical Society in April of this year a report of two cases, locally acquired and perhaps the first to be recognized in this State. These patients, husband and wife, have been under our continuous observation since December 6, 1929, and a case report thereon will be printed in CALIFORNIA AND WESTERN MEDICINE.

## CHRONAXIA\*†

ITS THEORY AND APPLICATION TO CLINICAL  
NEUROLOGY—WITH PRESENTATION OF A  
PORTABLE CHRONAXIMETER

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DISCUSSION by H. Douglas Eaton, M.D., Los Angeles;  
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THE power of the electric current to cause muscular contraction, when passed through the animal body, has been a part of medical knowledge for a great many years, but it remained for the pioneers of electrodiagnosis, among them Erb<sup>1</sup> and Duchenne de Boulogne,<sup>2</sup> to apply this phenomenon to the diagnosis of certain maladies affecting the muscles and nerves. All of our present clinical knowledge of the reaction of human nerve and muscle to the faradic and galvanic currents, with the variation brought about by injury or disease, can be traced to the work of these men, performed in the middle of the past century.

## VALUE OF ELECTRICAL REACTIONS IN NEUROLOGIC PRACTICE

There is a tendency in modern neurologic practice to put less and less stress on electrical reactions as an aid to diagnosis. I feel that this is due, not to any lack of a need for the information that might be so derived, but to the fact that, despite the tremendous strides which have been made in the refinement of our other diagnostic instruments in recent years, the determination of

\*From the Division of Neuropsychiatry, Stanford University School of Medicine. Read before the Neuropsychiatry Section of the California Medical Association at the sixty-third annual session, Riverside, April 30 to May 3, 1934.

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the electrical excitability of nerve and muscle is still frequently undertaken with the same crude apparatus available to our grandfathers. The resultant data, qualitative in nature, and subject to a great extent to the personal interpretation of the individual operator, thus seems unsatisfactory in comparison with the precise methods we are accustomed to expect in other present-day laboratory procedures.

There is no doubt that the determination of electrical excitability can give us information which can be gained in no other manner. It finds undisputed application in hysteria, cases of peripheral nerve injury, peripheral neuritis, and the various types of muscular atrophy and dystrophy, as well as in such conditions as myasthenia gravis and tetany.

With such a wide field of application, it was inevitable that technique should finally be advanced to a point where it was more adequate to meet the situation. The answer to the problem in this case was the application of chronaxia to the neurologic patient. The credit for this work belongs in a large measure to Bourguignon.<sup>3</sup>

#### PRINCIPLE OF CHRONAXIA

The principle of chronaxia (derived from the Greek *chronos*, "time") introduces the factor of the *time* during which the stimulating current acts, as well as the intensity of that current. The law of Du Bois-Reymond,<sup>4</sup> that the threshold of electrical excitability depended on the intensity of the stimulating current, but was independent of the length of time over which this current was allowed to act, was not successfully disputed until 1892, when Hoorweg,<sup>5</sup> by means of condenser discharges of very short duration, showed that intensities which would stimulate, when allowed to act over a considerable period, were ineffectual when their time of action was reduced to a few ten-thousandths of a second. Weiss,<sup>6</sup> in 1901, confirmed this, obtaining his current of short duration by an ingenious method whereby a pistol bullet was employed to close and open the circuit.

On the basis of this work, Lapique<sup>7</sup> developed his concept of chronaxia as the length of time, expressed in thousandths of a second, over which a current of twice the rheobasic intensity must act to produce a reaction. The rheobase is the galvanic threshold when the current acts for an infinite period, which for practical purposes need not exceed one second. Working with isolated nerve muscle preparations, he found this value to be quite constant for the species and the anatomical location from which the specimen was obtained.

#### BOURGUIGNON APPARATUS

In 1916 Bourguignon overcame the technical difficulties of the application of Lapique's apparatus and technique to the intact organism, and was able readily and accurately to determine the chronaxia of human nerve and muscle. Since that time there has been much work by Bourguignon and others in determining chronaxia both in normal and pathological states. Although chro-

naximetry has had a considerable vogue in the neurological centers of France and Germany, in this country it has but recently stepped from the physiological laboratory into the field of clinical neurology. It has the advantage over the older methods of determining the electrical reaction by making available a *quantitative* index of excitability, much less subject to the interpretation of the individual observer, and should thus overcome the main objections to the older methods.

The apparatus used by Bourguignon derives its currents of short duration from the discharge of condensers. The duration of the discharge of a condenser depends on two factors—the capacity of the condenser and the resistance of the circuit through which it discharges. By the employment of an ingenious system of high resistances in series and in parallel with the subject, it is possible to make the resistance of the discharge circuit practically constant, so that by varying the capacity of the condenser the duration of the current can be accurately controlled. Thus, the apparatus consists in essence of a source of direct current, derived from the ordinary house current after rectification and filtering, variable by means of a potentiometer from 0 to 300 volts. This current can be passed either through the discharge circuit directly, as in the determination of the rheobase, or utilized to charge a condenser of suitable capacity at twice the rheobasic voltage. This condenser is then discharged in the determination of the chronaxia.

In order to avoid polarization, the electrodes used are of the non-polarizable variety.<sup>8</sup> This is necessary because the sensitivity of the method would be impaired by polarization occurring with ordinary electrodes, which is not a significant factor with the grosser methods. The indifferent electrode consists of a sheet of silver, electrolytically covered with silver chlorid, 10 by 10 centimeters, applied by an elastic retainer to the subject's chest. The active electrode, which is the cathode, is a similarly treated silver disk, one square centimeter in area, mounted on a suitable handle. Both electrodes are kept moist by covering them with gauze saturated with physiological saline solution.

#### TECHNIQUE IN DETERMINATION OF CHRONAXIA

The determination of the chronaxia of a muscle is carried out as follows: the indifferent electrode is strapped to the subject's chest; with the active electrode the motor point is located. For this purpose the galvanic current is utilized, the circuit being made and broken by pressing knob *A* (see Fig. 1), while the intensity is controlled by turning knob *B*. When the motor point is found, the current is reduced by turning knob *B* to the left until a contraction can just be obtained. The voltage read on the voltmeter is the rheobasic voltage. The knob *B* is turned to the right until the voltmeter indicates double the rheobasic voltage, and the chronaxia is then determined by choosing a suitable condenser from the series controlled by

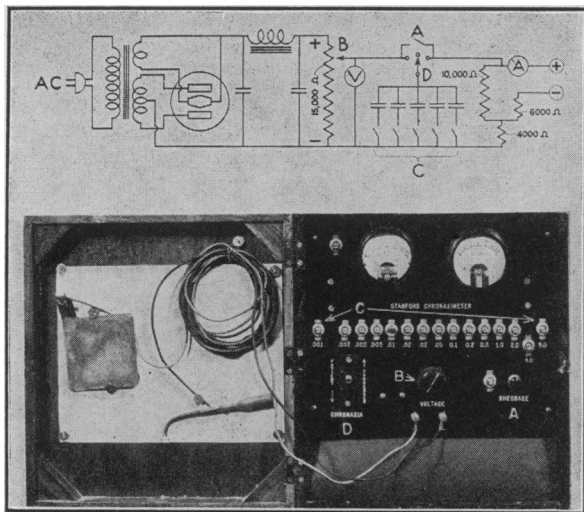


Fig. 1.—Portable Chronaximeter. (a) Rheobase switch. (b) Voltage regulator. (c) Condenser switches. (d) Chronaxia switch.

the bank of switches *C*, offering a continuous range of combinations from .001 to 11 microfarads; charging this condenser by throwing switch *D* upward, and then discharging the condenser through the subject by swinging switch *D* downward. The combination of condensers which will just produce a contraction is found by trial and error. This value in microfarads, as noted on the panel, is multiplied by Bourguignon's constant, 4, which gives the chronaxia of the muscle in sigma, or thousandths of a second.

Naturally, care must be exercised in the location of the motor point, as well as in the observation of the muscular contraction when the threshold is obtained. However, evaluation of the *speed and type of the contraction*, so important in the older methods, is here not essential, being merely confirmatory of the objective findings.

#### VALUES FOR VARIOUS MUSCLES

The values for various muscles in the normal have been carefully worked out by Bourguignon and others, and are remarkably constant from one individual to another. There is a fairly constant ratio of 2:1 between the muscles on the posterior aspect of an extremity and those on its anterior aspect, while the proximal segments of a limb have a shorter chronaxia than the distal segments. Thus Bourguignon gives the following values: for the proximal regions, the anterior muscles show a range from .06 to .14 sigma, the posterior from

.16 to .34 sigma; for the distal regions the values for the anterior muscles are from .16 to .34 sigma, for the posterior group from .40 to .70 sigma. Thus, for practical purposes, *any value over one-thousandth of a second can be considered pathological*. In cases which show the complete reaction of degeneration by the older methods, the chronaxia is found to be from 10 to 30 sigma, while in the muscular dystrophies values up to 80 sigma may be characteristically encountered. Thus we see that the definitely abnormal values are so far removed from the normal range as to make their recognition certain; while, by this more precise method, changes may be recognized long before they would become apparent with the orthodox method.

An example of the evolution of a case of peripheral facial palsy of undetermined etiology is shown in Table 1.

#### REPORT OF CASE

A housewife, age forty years, presented herself at Stanford Clinic with the history and findings of a practically complete facial palsy on the left, of a week's duration. Chronaxia measurements were made at that time, and at intervals thereafter. It can be seen that at the first entry, although the clinical picture was fully developed, there was no alteration in the electrical reaction. Throughout, the chronaxia of the facial nerve itself did not increase significantly, but two weeks after the onset two representative muscles, the frontalis and the orbicularis oris, showed much increased values. The movement in the frontalis returned first, heralded by a decrease in the chronaxia of this muscle, which was later followed by the orbicularis oris. Thus, we see remarkably good correlation between the clinical improvement and the reversion of the chronaxia to nearly normal values.

#### SUMMARY

In summary, it may be said that chronaximetry (which has until recently been considered a procedure confined to the physiological laboratory), can be readily applied to the problems of clinical neurology, and promises to reestablish the determination of electrical excitability in the position of importance which it deserves. It affords an easily obtainable index of the functional state of nerve and muscle which can be gained in no other manner, and provides a quantitative and objective measure of this functional state, which is not possible with the older methods of electrodiagnosis. Thus the determination of chronaxia is a valuable addition to the diagnostic and prognostic armamentarium of the clinical neurologist.

Stanford University School of Medicine.

TABLE 1.—Time After Onset

	One Week	Two Weeks	Three Weeks	Four Weeks	Six Weeks
Clinical course .....	Complete paralysis	Complete paralysis	Forehead improved	Mouth improved	Almost normal
Facial nerve .....	.28 sigma	.28 sigma	.8 sigma	1.2 sigma	1.2 sigma
Frontalis muscle .....	.28	12.0	6.0	1.2	.80
Orbicularis oris muscle...	.60	9.2	8.8	6.8	1.0

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## DISCUSSION

H. DOUGLAS EATON, M.D. (1136 West Sixth Street, Los Angeles).—There is no more important problem in neurology than the determination of the organic or functional character of a given condition. Accuracy in differentiation between a true organic nerve injury and an hysterical paralysis is not only of tremendous value to the patient, but may be of great economic importance. The ability to estimate the severity of an organic nerve injury, and to mathematically record its progress, endows us with real therapeutic insight. The development of a method giving an accurate quantitative valuation of muscle excitability promises to solve these problems for us, and to replace our present unreliable tests.

Doctor Newman's clear and concise article on chronaxia covers the subject completely. It is to be hoped that it will impress upon the general medical profession the fact that such a valuable diagnostic procedure is now practical and available.

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SAMUEL D. INGHAM, M.D. (727 West Seventh Street, Los Angeles).—Doctor Newman has given a very good outline of the principles of chronaxia, and has demonstrated a simple and practical apparatus for its application. For a long time the practice of neurology has suffered from the lack of an exact method of testing motor responses to electrical stimulation to the nerve or directly to the muscle. Even to the present day the most modern textbooks on neurology describe the reactions of degeneration in terms of their response to the faradic and galvanic current. There has been no standardization of faradic coils, and the faradic currents from different instruments show wide variations in voltage and other qualities. Response in muscles from faradic stimulation is quantitative, with no index for measurement. When the galvanic current is used in testing degenerated nerves, the response is both quantitative and qualitative, but still we have no method for measuring the deviation from the normal response. In the chronaximeter we have an instrument by which electrical impulses can be applied to the nerve or the muscle from a series of graduated condensers. We thus have a graduated scale which is easily standardized and which permits a fair comparison of the results obtained by different observers. This method of examination is also sufficiently sensitive to make it useful in the study of motor responses in many conditions not due to primary disease of the nerves and muscles; as, for example, the effect of different drugs and different diseased conditions upon the responses of the neuromotor mechanisms.

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ROBERT AIRD, M.D. (University of California Medical School, San Francisco).—In speaking of the clinical application of chronaxia, it is well to remember that

this measurement of the electrical excitability of tissue is but one phase of the excitability of tissue in general. Other modes of excitation are possible, but the accuracy obtainable with the electrical methods as worked out by Lapique and Bourguignon, make this method of particular value for the reasons stressed by Doctor Newman.

It is perhaps interesting to observe further that at the present time the principle of chronaxia is being studied more carefully in the laboratory. An ingenious young Englishman, Rushton, recently questioned Lapique's concept of chronaxia. With carefully controlled studies, he apparently obtained varying chronaxia on the same tissues, the variation depending on the size of the electrodes. He concluded that chronaxia, as ordinarily measured, is not characteristic of the tissue alone, but of the tissue and electrodes. He also brought evidence to show that muscle has two characteristic chronaxia—one probably of the muscle fibers themselves, and the other apparently associated with the innervating nervous elements. This latter would seem to be the one principally involved in the clinical test over the "motor point" of the muscle.

Such facts, however, do not invalidate the practical clinical application of this concept, within the limits proposed by Doctor Newman. As he has stressed, it is undoubtedly a great refinement over the older method. In the hands of a well-trained neurologist, conscious of the possible errors in technique, this method should prove of considerable value over the older methods, both in the diagnosis of doubtful cases and in following the course of neurological cases from a neuromuscular standpoint.

## BREECH EXTRACTIONS IN THE HOME\*

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DISCUSSION by Lyle G. McNeile, M.D., Los Angeles;  
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IN the period extending from June, 1929, to February, 1934, 5,805 women were delivered in their homes by Unit No. 1 of the Los Angeles Maternity Service. Breech presentations occurred 132 times, 2.3 per cent, which is slightly below the usual incidence. Of these 132 babies delivered, nineteen must be deducted for one or more of the following reasons; prematures, weighing less than three and one-half pounds (1,500 grams); macerated fetuses; monsters or deformities incompatible with life; and those in which the fetal heart was not heard during labor. Of the remaining 113 babies delivered, five were stillborn, or died during the neonatal period, a corrected mortality of 4.4 per cent. There were twenty-four primiparae, with one fetal death, a mortality of 4.1 per cent; and eighty-nine multiparae, with four fetal deaths, a mortality of 4.5 per cent. The average weight of the babies born of the primiparae was 6 pounds 9 ounces (2,950 grams), and of the multiparae 7 pounds 2 ounces (3,200 grams). A comparison of our fetal mortality, in breech presentations, with that of several other clinics is given in Table 1.

\* Read before the Obstetrics and Gynecology Section of the California Medical Association at the sixty-third annual session, Riverside, April 30 to May 3, 1934.